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Wholesale Milk Distribution Practices, Costs and Pricing In North Carolina

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Wholesale Milk Distribution Practices, Costs and Pricing In North Carolina

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PREFACE

This is the second in a series of studies designed to reduce the costs of distributing fluid milk in North Carolina. The first study, Case Handling Costs in Fluid Milk Plants, Agricultural Economics Information Series No. 81, dealt with the selection of conveyor systems and cold room designs. A study is under way dealing with the optimum size of distribution areas for branch sales stations.

This study is a contribution to Southern Regional Project SM-10, Revised, "Establishing Guides for Efficient Organization of the Dairy Industry Under Changing Conditions of the South." The project is a cooperative undertaking by the Agricultural Experiments Stations of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Texas and the Agricultural Marketing Service of the United States Department of Agriculture.

The author gratefully acknowledges the cooperation received from the distributors in North Carolina in offering their plant facilities and accounting data for analysis.

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SUMMARY

The costliest single phase of fluid milk marketing is distribution. The purpose of this study was to analyze factors affecting distribution costs and to point out ways of decreasing costs. Particular emphasis was placed on estimating the effects on costs of type of delivery service and size of delivery.

An intensive study was made of nineteen wholesale delivery routes operated by five distributors in five North Carolina cities. Stop watch measurements of the labor required to make deliveries of various sizes were taken. Appropriate wage rates were applied to these time requirements to obtain estimates of delivery labor costs. Truck costs were estimated from maintenance records of several plants. Costs that did not logically vary with volume per customer (such as truck licenses) were allocated equally among customers. The analysis indicated that the cost of "delivered milk" varied from $.32 per quart for individual deliveries of five quarts to $.22 per quart for individual deliveries of 350 quarts. Corresponding costs are associated with deliveries of intermediate size.

Further analysis of the routes indicated that cost savings of up to one-half cent per quart can be achieved by serving small customers on an every-other-day delivery basis. This shift in delivery practices can best be achieved if (1) the customers have some monetary incentive to accept less frequent delivery service, and (2) all distributors make the change simultaneously. A volume-discount pricing plan would lend substantial impetus to an industry-wide attempt to shift to less-frequent delivery practices. To be acceptable to the industry the discount schedule should reasonably accurately reflect actual cost differences associated with serving customers of varying size.

It was not considered feasible to design a volume-discount schedule which would correspond precisely to the actual costs associated with delivery volumes of various size. Such a plan would result in prohibitive price increases to very small customers. Instead, a sample discount plan was designed to partially reflect cost differences and still provide a substantial monetary incentive for small customers to consolidate their deliveries. The sample volume-discount schedule was designed so that distributors would receive the same total revenue as is received under the current flat price system. The discounts can be easily computed by the salesmen at each delivery. The new pricing plan involves an increase in the base price of milk to retailers to $.27 per quart with the following discounts:

Value of Delivery (dollars)	Discount (per cent of value)
0 - 2.49	0
2.50 - 7.49	6
7.50 -14.99	10
Over 15.00	15

If this discount schedule is applied to individual deliveries, approximately two-thirds of the customers included in the sample would have some monetary incentive to accept every-other-day service. Some of the smaller customers would have some additional incentive to accept fewer brands. It is logical to believe that most customers would prefer to seek discounts by accepting less frequent delivery rather than fewer brands if any consumer brand preference is present. Large stores already buying $15.00 per day from each distributor would have no incentive to accept fewer brands or less frequent delivery.

Weekly or monthly discount plans would provide no incentive for customers to accept less frequent delivery. The incentive to consolidate purchases could only be satisfied by accepting fewer brands. A monthly discount plan would therefore have the disadvantage of causing considerable anxiety among distributors over which brands would be dropped, and the further disadvantage of providing no incentive for small customers to accept less frequent delivery. A plan providing price discounts on each individual delivery is therefore to be strongly preferred.

If a volume discount plan such as the one illustrated is applied on an individual delivery basis, the cost saving in wholesale delivery could average one half cent per quart. At 1960 sales volumes, this could provide an annual cost saving of approximately two million dollars to the fluid milk industry of North Carolina.

Wholesale Milk Distribution Practices, Costs and Pricing In North Carolina

INTRODUCTION

The marketing of fluid milk can logically be divided into the three major components of assembly, processing and distribution. The costliest of these three components is distribution.1/ Technological improvements in the distribution of milk have occurred at a slower rate than improvements in processing and assembly. Although the adoption of the paper container and the gradual shift to refrigerated delivery trucks are two technological changes which have lowered delivery costs somewhat, milk distribution is still accomplished much the same as it was twenty years ago. Much of this seeming lag in technological change is a result of the very nature of the distribution function itself. As long as deliveries are made to individual homes and retail establishments, large quantities of labor will be required.

In spite of this inherently costly individual service, however, it is widely believed that distribution costs can be substantially reduced. The basis for this belief rests mainly in three conditions which seem to be generally characteristic of milk distribution:

(1) Wide variation in distribution costs among individual delivery routes.

(2) Variation in the types of distribution service extended by different distributors.

(3) Substantial duplication of delivery services in any given area.

The first two of these conditions suggest that distributors could make considerable use of detailed information on the costs involved for different types of delivery services, frequencies of delivery and volume per customer. Such information could help distributors to make more rational decisions on the types of delivery services and the route organizations which they wished to employ.

1/ United States Department of Agriculture, Agricultural Marketing Service, Marketing Costs and Margins for Fresh Milk, Miscellaneous Publication 733, February, 1959.

Cost information of this nature, however, will probably not be effective in reducing the duplication of delivery services. Such duplication is primarily caused by the institutional practice of combining the cost of the milk product and the cost of the delivery service into a single uniform price for "delivered milk." As long as these two components are combined into a single uniform price, the customer has no basis for selecting and paying for the frequency and type of delivery service which would be most appropriate for him. Instead he has no alternative but to demand as frequent and complete service as possible from as many distributors as are willing to deliver milk to him. It may be helpful, then, to develop and analyze several pricing arrangements which will provide some consideration for the cost of delivery to the individual customer. Such a pricing plan would provide the incentive for some customers to accept a less costly delivery service if it was available at a lower price.

Purposes of the Study

The purposes of the study are threefold:

(1) To provide information on the current practices and costs of milk distribution in North Carolina.

(2) To isolate and measure the effects of type of service and volume per customer on wholesale distribution costs.

(3) To compare the costs of deliveries to individual customers of various sizes with several alternative volume pricing plans and to point out the implications of each plan should the industry wish to consider one for adoption.

Scope of Study

The distribution of milk is carried on at both the wholesale and retail levels. Wholesale delivery consists of the delivery of milk and some milk products to grocery stores, drug counters, dairy bars, schools, hospitals and other institutions which buy milk for resale. Retail delivery consists of the delivery of milk to homes. Some delivery routes contain both wholesale and home delivery stops. The present study consists only of wholesale delivery routes.

Wholesale delivery is normally accomplished by a driver-salesman with a delivery truck. In some cases the driver-salesman employs a helper to do some of the routine delivery work. The analysis does not consider the feasibility of using a helper.

The driver-salesman typically performs a number of different activities. In addition to the actual delivery of milk to the individual customers, he usually loads the truck and arranges the milk within the truck, fills the truck with gas, washes out the truck after the deliveries are made, checks in returns and empty cases and balances the financial accounts at the end of the day. The present study deals primarily only with the actual delivery of milk to the customers. This is not meant to imply that the miscellaneous activities at the plant have been excluded from the estimation of delivery costs. They were excluded from the main body of the analysis because they have been adequately analyzed in other studies. Rather than duplicate the analysis of other studies, their results are used wherever they apply.

General Procedures

The general procedure was one of intensive study of nineteen wholesale routes operated by six distributors in five cities in North Carolina during the summer of 1959. No attempt was made to obtain a random sample of distributors or routes. The selection of the routes was made by the route supervisors.

A total of 641 individual deliveries were analyzed. The time requirements for each delivery were measured with a stop watch. The number and type of milk items were also recorded and related to the time requirements. Mileage and driving time between stops were also recorded and analyzed. Appropriate wage rates were applied to the delivery time requirements to obtain delivery labor costs.

Estimates of truck costs were obtained from truck maintenance records of several plants. The truck costs were allocated equally over the individual stops and added to the labor costs to obtain estimates of total delivery costs per individual stop. A functional relationship between delivery costs per individual stop and volume of milk delivered per stop was then formulated. This relationship between volume per stop and delivery cost was then compared with several alternative volume discount pricing schedules. Finally, the implications of these alternative volume pricing plans were discussed as to their conformity with the cost-volume relationship, their ease in application and their acceptability to the industry.

Applicability of Results

The data were obtained by averaging the information from nineteen wholesale routes. Since individual delivery routes and salesmen differ somewhat in their characteristics, the results of this study cannot be accurately applied to any individual route. This was not the intent of the study.

However, the results obtained in the study are applicable in a general way to wholesale milk delivery throughout North Carolina. The average time requirements for wholesale milk delivery to individual customers of the same type and volume do not vary appreciably from city to city or even from state to state.1/ Driving time requirements vary somewhat according to density of traffic and other conditions, but since these costs are computed separately from the delivery time requirements, it is a simple procedure to alter these estimates according to local conditions wherever necessary. It is believed, therefore, that the results obtained from this study will be generally valid for North Carolina and for much of the South.

GENERAL CHARACTERISTICS OF ROUTES STUDIED

Approximately 61 per cent of the fluid milk sold by plants in North Carolina is classified as wholesale delivery. Home delivery accounts for 25 per cent and special sales 2/ account for the remaining 14 per cent.3/

The general characteristics of the 641 individual stops included in the sample are given in Table 1. At about 15 per cent of the stops less than five quarts (or the equivalent in volume) were delivered, and at 10 per cent of the stops no milk was delivered. Yet most of the stops required the salesman to return six times per week. Small grocery stores kept an average of 2.24 brands of milk in their showcase but sold such small quantities of milk that more than 10 per cent of the time they required no delivery. It would appear that delivery costs could be reduced by putting these stops on a skip-day delivery basis. Possible cost savings obtainable by putting small stops on skip-day delivery will be discussed more fully later in the report.

Approximately 21 per cent of the total time away from the plant was spent driving between stops, 68 per cent in actual delivery and 11 per cent for personal time. These figures are based on the city routes included in the sample.

1/ This striking similarity in delivery time requirements is apparent upon comparison of the results obtained in this study with those obtained in Hugh L. Cook, Harlow W. Halverson and R. Wayne Robinson, Costs and Efficiency of Wholesale Milk Distribution in Milwaukee, Wisconsin Agricultural Experiment Station Research Bulletin 196, Madison, Wisconsin, May 1956, and David A. Clarke, Jr., Milk Delivery Costs and Volume Pricing Procedures in California, Cal. Agr. Exp. Bul. 757, December 1956.

2/ Special sales consists of bottled transfers to other plants and military sales.

3/ The wholesale-retail-special proportion of total sales was estimated on the basis of data submitted by plants selling 80 per cent of the total fluid milk in North Carolina.

Table 1. Characteristics of wholesale accounts included in sample

Type of stop	Number of stops in sample	Average number of distributors serving stop	Number of times no milk delivered
Large groceries	28	3.43	0
Small groceries	271	2.24	30
Restaurants	96	1.02	1
Service stations	87	1.06	5
Service station-groceries	59	1.19	0
Commissaries & drug counters	91	1.13	10
Schools	9	1.11	0

Source: Sample of 19 wholesale routes.

Considerable variation in this breakdown exists for different routes, depending on the average size of stop, traffic conditions and the industry of the driver.

COST ESTIMATION PROCEDURE AND RESULTS

For purposes of analysis delivery costs were broken down into two major components--labor costs and truck costs. Labor costs constitute approximately 77 per cent of total delivery costs and truck costs account for 23 per cent.

Labor Costs

Labor requirements were subdivided into delivery time, driving time, personal time, and time spent at plant. Each component was analyzed separately and will be discussed in turn.

Delivery Time Requirements

Delivery time for each stop was defined as starting when the driver-salesman halted the truck at the entrance of the individual stop to perform the delivery service and ended when he once more entered the truck to proceed to the next stop.

The delivery service itself was divided into the twelve independent tasks of secure order, assemble the order, carry the milk into the establishment, mark the prices on the containers, put the packages in the display case, accomplish the financial settlement, wait, talk, complete the delivery, rearrange the milk in the truck, perform miscellaneous other services and personal time. A complete description of each of these elements is given in Appendix A. Each of these elements was timed and recorded separately. 1/

Table 2 shows the relationship between time requirements and volume of milk delivered 2/ for those delivery elements most commonly performed. The percentage of delivery time spent, on the average, performing the different activities is given in parentheses.

Table 2 was developed by grouping the individual deliveries in class intervals by size of delivery and taking the average time requirement for all deliveries in this size interval. The average total time requirement for deliveries ranging from 160 to 299 quart equivalents is 28.2 minutes while the average total time requirement for deliveries of 20-39 quart equivalents is 8.4 minutes. While the larger of these two class intervals is approximately 6 times as large in volume as the smaller, the time requirement is only 3.5 times as large. This gives some indication of the smaller unit labor cost for larger deliveries.

1/ The subdivision of the delivery service into such small work elements was considered necessary to obtain a more precise measure of the relationship between cost of service and size of customer. At some stops not all of the work elements were performed. In a few cases the total delivery time at a stop was affected by events not normally associated with the delivery service. By subdividing the delivery task into its individual components, these outside sources of variation can be controlled or eliminated. Also by recombining these elements in various selected combinations, it is possible to reconstruct the costs of delivery for various types of service. For example, by eliminating the time requirements for "secure order," it would be possible to estimate the possible reduction in delivery cost obtainable by having the individual orders phoned in to the plant prior to the day's delivery.

2/ Volume of milk delivered is measured in terms of quart equivalents. Milk items other than quarts are considered in relation to the quantity of labor required to deliver the items in relation to the quantity of labor required to deliver a quart of milk. A half-pint is considered .6 quart equivalents because it requires as much work to deliver 10 half-pints of milk as it takes to deliver 6 quarts of milk. A discussion of several volume measures is given in Appendix B.

Table 2. Absolute time and proportion of total time spent performing various delivery activities, by size of delivery

Volume of stop (quart equivalents)	Secure order (min.)(%)	Assemble the order (min.)(%)	Deliver & complete delivery (min.)(%)	Put in icebox (min.)(%)	Collect (min.)(%)	Mark prices (min.)(%)	Wait (min.)(%)	Talk (min.)(%)	Other services (min.)(%)	Total (min.)(%)
0-9	1.39 (37)	.54 (14)	.73 (19)	.39 (10)	.52 (13)	(0)	.19 (5)	.09 (2)	.01 (0)	3.86 (100)
10-19	1.75 (26)	.87 (13)	.84 (12)	.86 (13)	.71 (10)	1.35 (20)	.20 (3)	.20 (3)	.02 (0)	6.80 (100)
20-39	2.14 (26)	1.32 (16)	1.05 (12)	1.32 (16)	.84 (10)	.88 (10)	.44 (5)	.19 (2)	.23 (3)	8.41 (100)
40-59	2.63 (25)	1.87 (17)	1.30 (12)	1.96 (18)	.95 (9)	1.46 (14)	.23 (2)	.37 (3)	.05 (0)	10.82 (100)
60-79	3.25 (20)	2.62 (17)	2.19 (14)	2.63 (17)	1.23 (8)	1.90 (12)	.24 (2)	.15 (1)	1.37 (9)	15.58 (100)
80-119	3.82 (21)	2.88 (16)	2.68 (15)	3.36 (20)	1.28 (7)	2.02 (11)	.90 (5)	.35 (2)	.48 (3)	17.77 (100)
120-159	4.76 (20)	3.45 (15)	3.58 (16)	3.08 (13)	1.68 (7)	3.07 (13)	.95 (4)	1.37 (6)	.89 (4)	22.83 (100)
160-299	4.78 (17)	4.06 (14)	4.54 (16)	5.60 (20)	1.45 (5)	4.23 (15)	1.18 (4)	1.36 (5)	1.21 (4)	28.41 (100)
300-599	3.76 (12)	5.06 (16)	5.89 (19)	5.38 (17)	1.26 (4)	6.40 (21)	.85 (3)	.00 (0)	2.60 (8)	31.20 (100)

Source: Time and motion study of 19 wholesale routes operated by five firms in five cities in North Carolina.

A more useful method of describing the relationship between time requirements and size of delivery was obtained by fitting a mathematical relationship to the time-volume data. In Figure 1 the time-volume data are graphed with "volume delivered" measured on the horizontal axis and "delivery time" on the vertical axis. The mathematical relationship describes the line which is drawn through the scatter in such a way that it "fits" the scatter best. The mathematical equation 1/ which describes this line is:2/

$$T = .082 + .52 \log V$$

where T = time requirements in minutes required for securing order, putting up the order, delivering the milk, putting the milk in the display case and making the financial settlement,3/

and V = size of delivery in quart equivalents.

The equation can be used to estimate the average time requirements for performing these delivery services for customers of any size up to 350 quart equivalents 4/ merely by substituting the appropriate volume into the equation in place of V and solving for the corresponding value for T. Furthermore, by applying appropriate cost rates to these physical delivery time requirements, the delivery costs of deliveries of varying volume can be estimated. These costs can be attributed directly and reasonably accurately to the individual customer as determined by his size of individual delivery.

1/ Since the statistical specifications of the variables in this equation do not conform to those required for tests of significance, no interpretation can be placed on the coefficients or the goodness of fit. Confidence in the explanatory power of the mathematical relationship can be derived only from subjectively viewing the pattern of the scatter in Figure 1 and noting the variation around the line. Much of this scatter is due to differences in number of products delivered, distance between the truck and the display case, degree of congestion in the store, etc.

2/ In deriving this equation the data for many of the small stops were discarded to simplify the computations. Since the overall sample included an excessive number of small stops, the small stops were randomly arrayed and only every fifth stop was used. Since the variations in the time requirements for small stops were small, it is believed that the results were not greatly affected by using only a part of the data.

3/ These five delivery elements make up the major part of the delivery task. Other activities such as personal time, arranging milk in the truck, etc., were omitted because they were performed infrequently.

4/ No usable data were obtained for delivery volumes in excess of 350 quart equivalents.

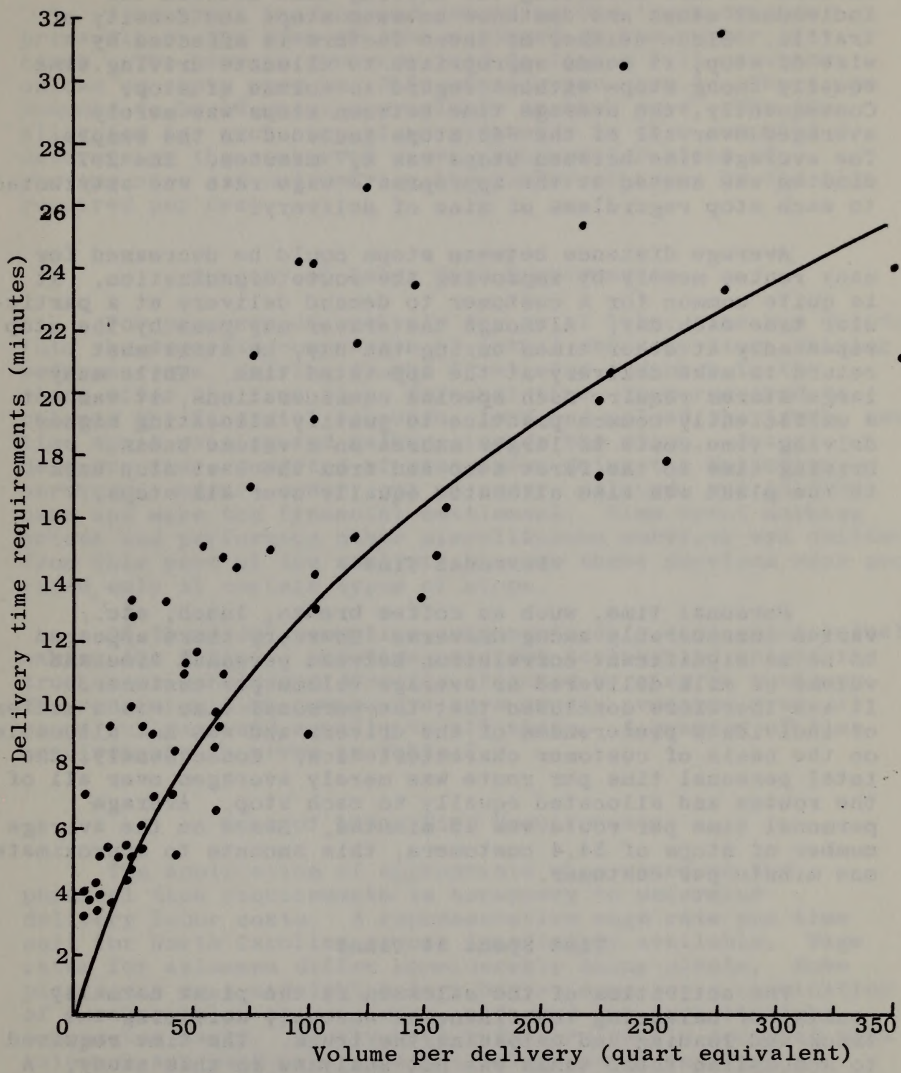

Figure 1. Relationship between volume per delivery and delivery time requirements

Driving Time Requirements

On the average, approximately 21 per cent of the route time spent away from the plant is spent driving between stops. Obvious factors affecting the driving time between the individual stops are distance between stops and density of traffic. Since neither of these factors is affected by size of stop, it seems appropriate to allocate driving time equally among stops without regard to volume of stop. Consequently, the average time between stops was merely averaged over all of the 641 stops included in the sample. The average time between stops was 2.7 minutes. The 2.7 minutes was costed at the appropriate wage rate and attributed to each stop regardless of size of delivery.

Average distance between stops could be decreased for many routes merely by improving the route organization. It is quite common for a customer to demand delivery at a particular time each day. Although the driver may pass by the stop repeatedly at other times during the day, he still must return to make delivery at the appointed time. While many large stores require such special considerations, it was not a sufficiently common practice to justify allocating higher driving time costs to larger stores on a volume basis. Driving time to the first stop and from the last stop back to the plant was also allocated equally over all stops.

Personal Time

Personal time, such as coffee breaks, lunch, etc., varies considerably among drivers. However, there appeared to be no significant correlation between personal time and volume of milk delivered or average volume per customer. It was therefore concluded that the personal time was a matter of individual preferences of the drivers and was not allocable on the basis of customer characteristics. Consequently, the total personal time per route was merely averaged over all of the routes and allocated equally to each stop. Average personal time per route was 35 minutes. Based on the average number of stops of 34.4 customers, this amounts to approximately one minute per customer.

Time Spent at Plant

The activities of the salesmen at the plant normally consist of balancing the financial account, servicing the truck and loading and unloading the truck. The time required to accomplish these tasks was not analyzed in this study. A study of wholesale milk distribution in Milwaukee 1/ resulted in

1/ Hugh L. Cook, Harlow W. Halverson and R. Wayne Robinson, Costs and Efficiency of Wholesale Milk Distribution in Milwaukee, Wisconsin Agr. Exp. Sta. Res. Bul. 196, May 1956.

an estimate of 31.7 minutes for the financial accounting. An additional ten minutes was assumed to be a reasonable allowance for servicing the truck. The 41.7 minutes were allocated equally among the 34.4 customers (average per route).

Time spent loading and unloading the truck depends primarily on the size of load measured in the number of cases. The average time required to load a full case and unload an empty case is .2184 minutes per case.1/ There are assumed to be 16 quart equivalents in each case. The time allocated for each stop of varying size is then computed by determining the number of cases required for stops of varying size and multiplying the number of cases by the time required per case.

Summary of Labor Time Requirements

For purposes of analysis the total labor time was divided into the separate components of actual delivery time, driving between stops, driving to the first stop and back to the plant after the last stop, personal time, time required to balance the financial accounts, load and unload the truck, and time spent waiting and talking inside the store. Actual delivery time consisted of time spent doing the following services: secure order, put up order, deliver, put in show case and make the financial settlement. Time spent marking prices and performing other miscellaneous services was omitted from this part of the analysis because these services were provided only at certain types of stops.

Of these delivery time components only time spent actually making the delivery and time required to load and unload the truck were considered directly affected by size of customer. The remaining time components were merely averaged over all stops and assessed equally to all stops. A summary of time requirements is given in Table 3.

Cost of Labor Time Requirements

The application of appropriate wage rates to the physical time requirements is necessary to determine delivery labor costs. A representative wage rate per time unit for North Carolina is not immediately available. Wage rates for salesmen differ considerably among plants. Some plants pay on a straight salary basis; some pay a combination of a salary plus a commission, and some pay on a straight commission basis. Hourly wage rates are easily computed when salesmen are paid on a straight salary basis and work a standard number of hours per day. However, the appropriate hourly wage rate is obscured when salesmen are paid on a

1/ This estimate was derived in R. L. Simmons, Case Handling Costs in Fluid Milk Plants, N.C. Agr. Exp. Sta. Info. Series No. 81, December 1960.

Table 3. Summary of labor time requirements as related to size of stop

Volume delivered (qt. equiv.) (1)	Delivery time at stop (minutes) (2)	Time loading and unloading (minutes) (3)	Fixed delivery time (minutes) (4)	Total delivery time (minutes) (5)	Delivery time per quart equiv. (minutes) (6)
5	2.78	.07	6.21	9.06	1.81
10	3.99	.14	6.21	10.34	1.03
15	4.93	.21	6.21	11.35	.76
20	5.72	.27	6.21	12.20	.61
30	7.07	.41	6.21	13.69	.46
50	9.21	.68	6.21	16.10	.32
75	11.38	1.02	6.21	18.61	.25
100	13.22	1.37	6.21	20.80	.21
125	14.84	1.71	6.21	22.76	.18
150	16.32	2.05	6.21	24.58	.16
175	17.67	2.39	6.21	26.27	.15
200	18.95	2.73	6.21	27.89	.14
250	21.28	3.41	6.21	30.90	.12
350	25.35	4.78	6.21	36.34	.10

Sources:

Col. (1) Arbitrary size classifications selected to show the effects of volume per stop on delivery time requirements.

Col. (2) Estimated by the mathematical relationship, $Y = .082 + .52 \log V$.

Col. (3) Estimated from labor standards derived in Richard L. Simmons, Case Handling Costs in Fluid Milk Plants, Ag. Econ. Info. Series No. 81, December 1960. Time required to load one case of milk and unload one empty case is .2184 minutes. There was assumed to be 16 labor units per case.

Col. (4) Includes 2.7 minutes driving between stops, 1 minute for personal time and .81 minutes for waiting and talking inside the store, 1.2 minutes for accounting at the plant and .5 minutes for driving to the first stop and back to the plant from the last stop.

Col. (5) Sum of Cols. (2)-(4).

commission basis and the length of the work day is variable. There are those who maintain that economies of large deliveries are impossible when salesmen are paid a fixed amount (commission) on each unit sold. The delivery cost per quart would be constant regardless of the quantity delivered. However, such an argument avoids the real issue. Column 6 of Table 3 clearly shows that labor requirements decrease from 1.8 minutes per quart in the case of a five quart delivery to .10 minutes per quart for a 350 quart delivery. This represents a substantial difference in labor requirements per quart.

Plant managers must pay their salesmen a wage that is competitive with wages elsewhere for an equivalent amount of daily physical and mental exertion. They may pay this competitive wage either by a straight daily or weekly salary or on a commission basis. The method of payment is irrelevant. Salesmen compare the amount of daily labor required to deliver milk with the quantity of labor they would be required to do elsewhere at an equivalent income. Thus, regardless of the method of payment, the salesman is paid roughly according to the amount of labor he is required to do. The amount of labor expended in the delivery of a unit of milk for customers of different volume is therefore of crucial importance to the plant manager in setting up an efficient delivery system.

The hourly wage rate to be applied to the physical time requirements was determined as follows: The average weekly take home pay of wholesale route drivers was estimated from some actual plant payroll records to be $108.36. To this was added $18.06 for the costs of a route supervisor. (One route supervisor per 6 routes was judged to be common practice in the industry.) Then 10 per cent of the basic $108.36 was added for vacations, social security, sick leave and other miscellaneous fringe benefits. This gave a weekly cost of $137.26 per route driver. Assuming 6 days of work per week at an average of 10 hours per day gives an hourly rate of $2.29 and a rate per minute of $.038. Labor cost per quart equivalent was then estimated by applying this cost rate to the physical time requirements listed in Table 3. Delivery labor costs for deliveries of varying size as estimated by this procedure are given in Table 4.

Truck Costs

The type of truck used for the analysis was a two-ton, cab and van, refrigerated wholesale delivery truck similar to the type widely used in North Carolina.

For purposes of analysis truck costs were divided into two independent components--fixed costs and variable costs. Fixed costs are those costs which do not normally vary with mileage. Such costs include interest on the investment, taxes, insurance, depreciation and licenses. Variable costs are those costs which vary with mileage--namely, gasoline, oil, tires and batteries, repairs and maintenance.

Fixed truck costs were estimated on the basis of the current replacement cost of the truck. Depreciation was allocated on a straight line basis over the estimated life of the truck, which was assumed to be eight years. Interest costs on the capital investment were estimated on the basis of 3 per cent of the initial purchase price of the truck. (This rate is equivalent to approximately 5 1/2 per cent on the unamortized value of the truck.) Taxes were included at a rate of 1.5 per cent of the purchase price of the truck. Insurance

Table 4. Summary of delivery labor costs associated with deliveries of various sizes a/

Volume delivered (1)	Delivery labor cost (2)	Cost per quart equiv. (3)
(quart equiv.)	(dollars)	(dollars)
5	.344	.069
10	.393	.039
15	.431	.029
20	.464	.023
30	.520	.017
50	.612	.012
75	.707	.010
100	.790	.008
125	.865	.007
150	.934	.006
175	.998	.006
200	1.060	.005
250	1.174	.005
350	1.381	.004

a/ The delivery elements "mark prices," and "other services" have been omitted from these computations because they are not performed at all stops. These elements are analyzed separately in Table 8 and the effect on delivery costs noted.

Sources: Col. (1): Col. 1, Table 3.
Col. (2): Col. 5, Table 3 multiplied by $.038.
Col. (3): Col. 6, Table 3 multiplied by $.038.

rates and license costs were based on costs reported by a number of actual plants. The annual and daily fixed costs for the operation of one truck, based on a purchase price of $5,000, are given in Table 5. Fixed labor costs for truck repair and maintenance were assumed to be incurred through the use of full-time mechanics employed at a cost per mechanic of $5,000 per year. Each mechanic is assumed to service 11 trucks.

There are other minor costs associated with truck ownership and operation but further listings would not appreciably alter the cost estimates.

Variable truck costs were estimated from plant records on truck maintenance for 21 trucks operated by two different companies. The records consisted of a two year accumulation of monthly records of mileage, gasoline and oil consumption and the purchase cost of spare parts.

Gas consumption per mile seemed to be inversely related to the distance driven per year. This can be attributed to the fact that lower annual mileages were associated with city routes which have shorter distances between stops and more

Table 5. Fixed truck costs for wholesale delivery

Annual fixed costs	
Depreciation a/ (8 year life)	$625
Interest (3% on purchase price) b/	150
Taxes (1.5% on purchase price) c/	75
License	120
Insurance d/	100
Storage e/	50
Garage labor f/	460
Annual total	$1,580.00
Daily total (313 delivery days)	$ 5.05

a/ Based on a purchase price of $5,000.
b/ This rate is equivalent to approximately 5 1/2% on the unamortized value.
c/ Equivalent to about 2.5% of listed value.
d/ Includes fire, theft and liability.
e/ Storage or parking lot for 1/10 acre per truck.
f/ Assumes 11 trucks per garage mechanic, with garage mechanic costing the plant $5,000 per year.

driving in congested areas. The estimation of variable costs per mile was therefore accomplished in such a way as to allow for this variation in driving conditions. Gasoline costs were separated from the other components and estimated by the mathematical relationship:

$$C = .278 - .008545D$$

where C = consumption of gasoline in gallons per mile, and D = mileage per year in thousands of miles.

Table 6 summarizes the variable truck costs.

Table 6. Variable truck costs per mile

Oil a/	$.0023
Tires and parts a/	.0239
Gasoline b/	.0455
Total	$.0717

a/ Based on a two year accumulation of monthly plant maintenance records.

b/ Estimated from the equation C = .278 - .0085D where

C = gas consumption in gallons per mile,
D = annual mileage in thousands of miles.

Truck costs can be considered a joint cost to be allocated over all of the stops on an equal basis.1/ This is true of variable costs as well as fixed costs. The procedure to determine total variable cost per route and per stop was as follows: (1) Average route length for the sampled routes was 36 miles. Assuming the route was served six times weekly, annual mileage would be 11,268 miles. (2) Average gasoline consumption per mile for a route of this length is computed from the equation C = .278 - .008545D to be .182 gallons per mile. Assuming a price of 25 cents per gallon, this would be $.0455 per mile. (3) Adding the other variable costs to the gasoline cost, the total variable costs per mile would be $.0717, or $1.68 per route day. (4) Adding the daily variable costs to fixed costs, the total truck costs per route day are $6.73. (5) The total truck costs per stop with an average of 36 stops per route are $.187 per day.

1/ Some authors allocate the truck costs among individual stops on the basis of the proportion of truck space used. This allocation is logical only if the truck space is fully utilized or if larger trucks are used for routes with a high proportion of larger stops. The common practice in North Carolina is to attempt to give to each driver approximately the same total route volume, so that salaries will not be too unequal when paid on a commission basis. Since each driver then has a large number of small customers, available delivery time becomes the factor limiting total daily deliveries rather than truck space. The proportion of routes fully utilizing truck capacity is small.

Total Delivery Costs

Labor costs from Table 4 and truck costs as estimated on page 20 are added together to get total delivery costs as listed in Table 7. A sharp decrease in delivery costs per quart up to a delivery size of 30 quart equivalents is illustrated in the table. Further decreases of a lesser magnitude are available for stops up to 75 quart equivalents. Costs per quart decrease very slowly for deliveries larger than 75 quart equivalents. This particular cost relationship seems logical in view of current delivery practices. Five cases can be conveniently handled in one trip with a hand truck. Deliveries larger than five cases require extra trips. Thus, further economies are negligible for deliveries in excess of 75 units. The rapid decrease in unit costs of deliveries of up to 20 quart equivalents is a result of two factors: (1) It takes very little additional time to carry a full case of milk than it takes for one quart, so variable delivery costs do not increase appreciably, and (2) the fixed delivery costs--truck costs, personal time, time spent driving from the last stop, etc.--are spread over more units.

This completes the analysis of the costs associated with deliveries. Costs which could logically be expected to depend on size of delivery were estimated by functional relationships between delivery costs and size of delivery. "Joint costs," or those costs not logically associated with size of delivery, were allocated over all stops equally. The assumption that "joint costs," such as truck insurance costs and truck depreciation costs, should be shared equally by all customers will not gain universal acceptance. Some will argue that larger customers should bear a higher proportion of these costs. Cost estimates would have been slightly different had such an allocation been made.1/ It can only be hoped that the cost estimation procedures have been explained in sufficient detail to allow the reader to make other allocations based on his own assumptions. It was for this reason that the costs were divided into such small components and analyzed individually.

Special Services for Special Customers

Many large grocery supermarkets recognize that substantial economies in delivery costs are associated with their large volume purchases. Since volume discounts are currently disallowed under State Milk Commission Fair Trade Practice Order No. 5, February 1960, these large stores have sought to retain

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1/ Since 77 per cent of all delivery costs are due to labor costs, and since approximately 86 per cent of the labor costs are traceable to functional relationships between time requirements and volume per delivery, it appears that the results of the analysis would not have been greatly different regardless of the methods of allocation of joint costs.

Table 7. Total delivery costs and costs per unit for deliveries of various size a/

Volume delivered (1)	Labor costs (2)	Truck costs (3)	Total costs (4)	Costs per quart equiv. (5)
(quart equiv)		(dollars)		
5	.344	.187	.531	.106
10	.393	.187	.580	.058
15	.431	.187	.618	.041
20	.464	.187	.651	.033
30	.520	.187	.707	.024
50	.612	.187	.799	.016
75	.707	.187	.894	.012
100	.790	.187	.977	.010
125	.865	.187	1.052	.008
150	.934	.187	1.121	.007
175	.998	.187	1.185	.007
200	1.060	.187	1.247	.006
250	1.174	.187	1.361	.005
350	1.381	.187	1.568	.004

a/ The delivery elements "mark prices" and "other services" have been omitted in this table because they are not performed at all stops. They are analyzed in Table 8 and their effects on delivery costs are noted.

Sources:
Col. (1): Col. (1), Table 3.
Col. (2): Table 4, Col. (2).
Col. (3): Discussion on page 21.
Col. (4): Col. (2) plus Col. (3).
Col. (5): Col. (4) divided by Col. (1).

some of these economies by requiring special delivery services not normally provided other customers. Such services include marking prices on the containers, washing the display case once a week, returning to the store on weekends to rearrange the milk in the display case, and in some cases, the hiring of a special worker to keep the display case full. Part of the incentive to provide these services arises from the delivery man himself. Anxious to satisfy the large customers and retain his quota of space in the display case, the delivery man is usually quite willing to provide these extra services.

Although the provision of these additional delivery services is inherently neither good nor bad, they do add to the monetary cost of delivery. To the extent that additional delivery services for these stops are provided, the cost-volume estimates given in Table 7 underestimate the cost of delivery to some large stops. Table 8 represents a tentative analysis of the costs of these extra services. The results

Table 8. Total delivery costs and cost per unit for "complete service deliveries of various size"

Volume delivered (1)	Total delivery time (2)	Mark prices (3)	Other services (4)	Wash box (5)	Monitor case on Fri., Sat. (6)	Total labor time (7)	Total delivery cost (8)	Delivery cost per unit (9)
(labor units)				(minutes)			(dollars)	(dollars)
5	9.06	0	0	--a/	--	9.06	.53	.106
10	10.34	1.20	0	--	--	11.54	.63	.063
15	11.35	1.30	.10	--	--	12.75	.67	.045
20	12.20	1.40	.20	--	--	13.80	.71	.036
30	13.69	1.50	.40	--	--	15.59	.78	.026
50	16.10	1.70	.50	--	--	18.30	.88	.018
75	18.61	2.00	.70	--	--	21.31	1.00	.013
100	20.80	2.30	.80	5.0	6.6	35.50	1.54	.015
125	22.76	2.60	.95	5.0	6.6	37.91	1.63	.013
150	24.58	2.85	1.05	5.0	6.6	40.08	1.71	.011
175	26.27	3.15	1.20	5.0	6.6	42.22	1.79	.010
200	27.89	3.45	1.30	5.0	6.6	44.24	1.87	.009
250	30.90	4.00	1.50	5.0	6.6	48.00	2.01	.008
350	36.34	5.20	1.75	5.0	6.6	54.89	2.27	.006

a/ Not performed.

Sources:

Col. (1), (2): Taken from Table 6.

Col. (3): The delivery element "mark prices" was timed separately and recorded with volume. The figures represent simple averages of recorded times for some arbitrary class intervals. The mid-points of these intervals are listed in Col. (1).

Col. (4): Estimated in a similar manner to Col. (3). Other services include moving milk from the store's refrigerator to the display case and a few other miscellaneous tasks.

Col. (5): Assumed to require 30 minutes once a week. Six deliveries per week were assumed.

Col. (6): Assumes ten minutes driving time to reach store and ten minutes to arrange milk in display cases. Accomplished on Friday and Saturday.

Col. (7): Summation of Col. (2) - Col. (6).

Col. (8): Col. (7) multiplied by labor cost per minute ($.038) plus truck costs ($.187).

Col. (9): Col. (8) divided by Col. (1).

of this analysis indicate that while delivery costs are increased slightly for some large deliveries, substantial economies are still present.

VOLUME DISCOUNTS

The fact that substantial cost economies are often associated with individual deliveries of large volume has been recognized in many industries for decades. Volume discounting procedures are common methods of reflecting such economies.

Volume discounts based on cost economies are explicitly legalized in section 2(a) of the Robinson-Patman Amendment to the Clayton Act. Volume discounts in milk delivery are common in many parts of the United States. The "Fluid Milk and Cream Report" of October 18, 1961, lists volume discounts for home delivered milk in 40 of 157 city markets. Discounts for wholesale deliveries are probably about as common, although no such information on wholesale delivery is regularly reported.

Most Federal marketing orders do not contain fair trade laws. The choice of pricing practices is left with distributors, subject, of course, to broad constraints imposed by Federal anti-trust and fair trade laws. In contrast, most state marketing orders contain quite extensive fair trade laws. Practically all state milk marketing orders declare discounts and rebates to be illegal. 1/

No research studies on the effects of a volume discount in milk delivery have been published to date. It is possible, however, to speculate about some of the administrative and control aspects of such a program. First, a volume pricing plan might help to alleviate the intense struggle for large volume customers. Under a flat pricing system large customers are more lucrative than small ones because of lower unit delivery costs.2/ Distributors often try to attract large customers by giving secret discounts and rebates, renting refrigeration equipment at low rates, making generous loans, and other activities which may or may not be considered legal in the state fair trade laws. Where these activities are effectively checked by a vigilant control system, the large volume customers tend to acquire their own bottling and distribution facilities. To forestall such a shift in the ownership of distribution facilities, state laws are often passed enabling retail price-fixing. Whether or not price-fixing laws prove in the long run to be effective mechanisms

1/ A notable exception in this respect is California, which requires volume discounts in both wholesale and retail markets.

2/ There are other reasons why large customers are lucrative. They help to increase plant volumes and sales.

for maintaining market stability depends on future court contests. A volume pricing scheme which is uniform in application over the entire state may (1) reduce the motivation of distributors to circumvent fair trade laws in order to offer special favors to large customers, (2) reduce the tendency for chain stores to acquire their own distribution facilities, and (3) obviate the need for price-fixing laws.

In view of these rather profound effects of pricing arrangements on industry structure, it might be of interest to investigate a specific volume discount program based on the cost data presented in this report.

The costs as outlined in Table 7 are not in a form which can be used easily by the industry in a volume pricing plan. The wholesale price as presently quoted to customers is a "delivered price" for milk--that is, it includes the price of the milk and the price of the delivery service. The analysis thus far has estimated the cost of delivery. The price of the milk product must also be estimated so that it may be recombined with the cost of delivery to customers of varying size to obtain an estimate of "delivered price" to each customer.

The average at-plant price of milk was estimated by subtracting the estimated average cost of delivery from the current average wholesale price for delivered milk. The average cost of delivery was estimated by dividing the total daily delivery cost by the average route size in labor units. Total daily labor cost as estimated on page 17 was $22.88 and total daily truck costs are $6.73 as estimated on page 20. The combined daily total is therefore $29.61. The average route volume of the 19 routes studied was 1,247 quart equivalents. Dividing the daily route cost by the average route volume gave an estimate of 2.37 cents per quart equivalent for the delivery cost.1/ The most common price to wholesale accounts is 24 cents per quart delivered in paper. Subtracting the average delivery cost from the wholesale price gives an at-plant price of 21.63 cents per quart of regular homogenized milk in paper cartons.

1/ It is of some interest to compare this average cost of delivery per quart with estimates from other studies in other parts of the country. Average wholesale delivery costs in Milwaukee in 1956 (Wisconsin Agr. Exp. Sta. Bul. 196, May 1956) were estimated to be 1.5 cents per quart. A similar study completed in Los Angeles (California Agr. Exp. Sta. Mimeographed Report No. 236, Nov. 1960) indicated that delivery costs averaged 1.6 cents per quart. In both cases the average size of delivery was substantially larger than the average size of delivery on the routes studied in North Carolina. Hence, one would expect substantially higher delivery costs in North Carolina.

Figure 2 illustrates the variation in delivered prices which would occur if the delivery service is priced separately from the milk product. The current wholesale price of 24 cents underprices the product approximately 8 cents per quart to customers buying only five quarts of milk at each delivery. On the other extreme the 24 cents flat price overprices the product about two cents per quart to customers taking 100 labor units or more per delivery.

It is probably not feasible to attempt to formulate a discount schedule which would exactly correspond to the relationships shown in Figure 2. Besides being complicated to administer, it would evoke a storm of protest from the small customers. The act of raising the delivered price of milk from 24 cents to 32 cents to customers taking 5 quarts or less would probably cause some of them to stop handling milk. Although some of the smaller customers might be dropped with beneficial results to delivery costs, the primary purpose of the discount is to motivate small customers to consolidate their purchases by taking less frequent delivery and, in some cases, fewer brands. This consolidation would make profitable customers out of unprofitable ones. Of the two types of consolidations (1) fewer brands and (2) less frequent deliveries, possible overall economies to the industry are about equal. This fact holds important implications for the type of discount schedule used. Discounts based on monthly total deliveries would provide absolutely no incentive to customers to take less frequent service. In order to obtain the cost savings associated with skip-day delivery to small customers, it is necessary to apply the discount to each individual delivery. If the discount were applied on a monthly basis, the only basis for consolidation to obtain discounts would be to carry fewer brands. A monthly volume discount plan would therefore cause considerable competitive dislocations among brands and possible economies would be obscured by instability in the industry. A discount plan on individual deliveries would be strongly preferred because it would allow considerable shifts to every-other-day delivery and would lighten the motive of stores to carry fewer brands.

Types of Volume Discounts

The two most common types of differential pricing procedures are the "service charge" and the "volume discount." The "service charge" method prices the distribution service and the milk product separately. A flat service charge to all customers as a separate payment is assessed for each delivery. This procedure can provide a schedule of effective prices for customers of varying size which corresponds quite closely with the estimated volume-cost relationship illustrated in Figure 3. The broken line graphed on Figure 3 represents the price to customers which would occur under a flat price of 22 cents per quart of milk plus a service charge of 50 cents

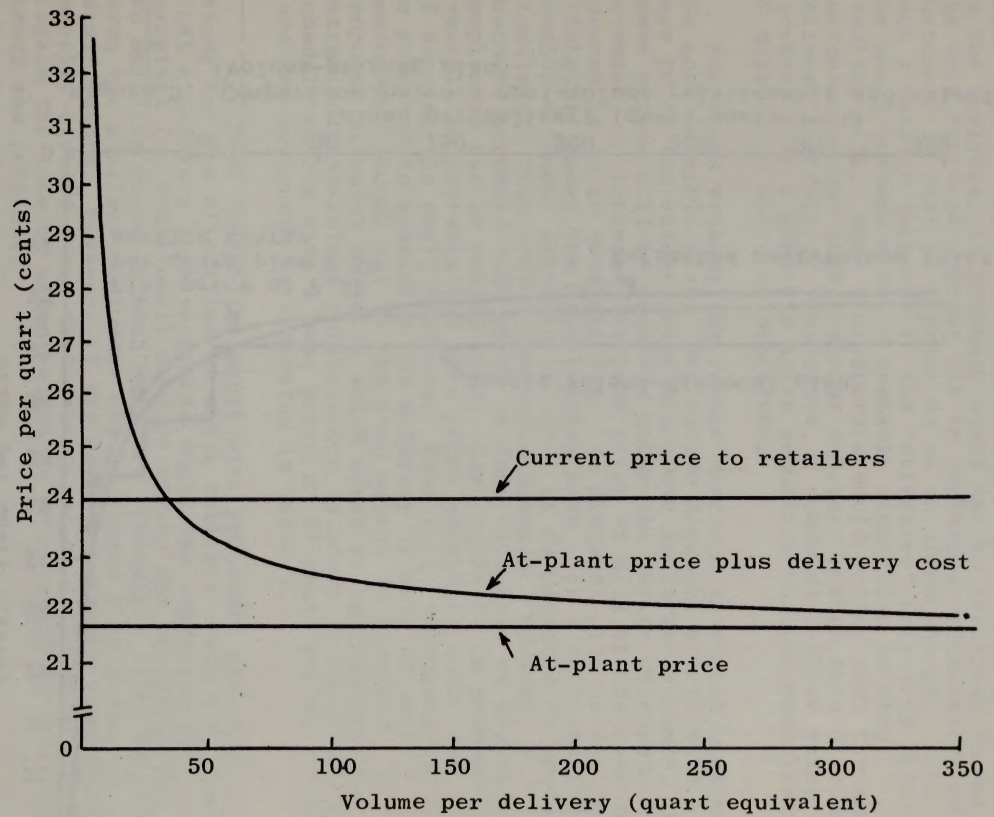

Figure 2. Relationship between volume per delivery and delivery costs per quart

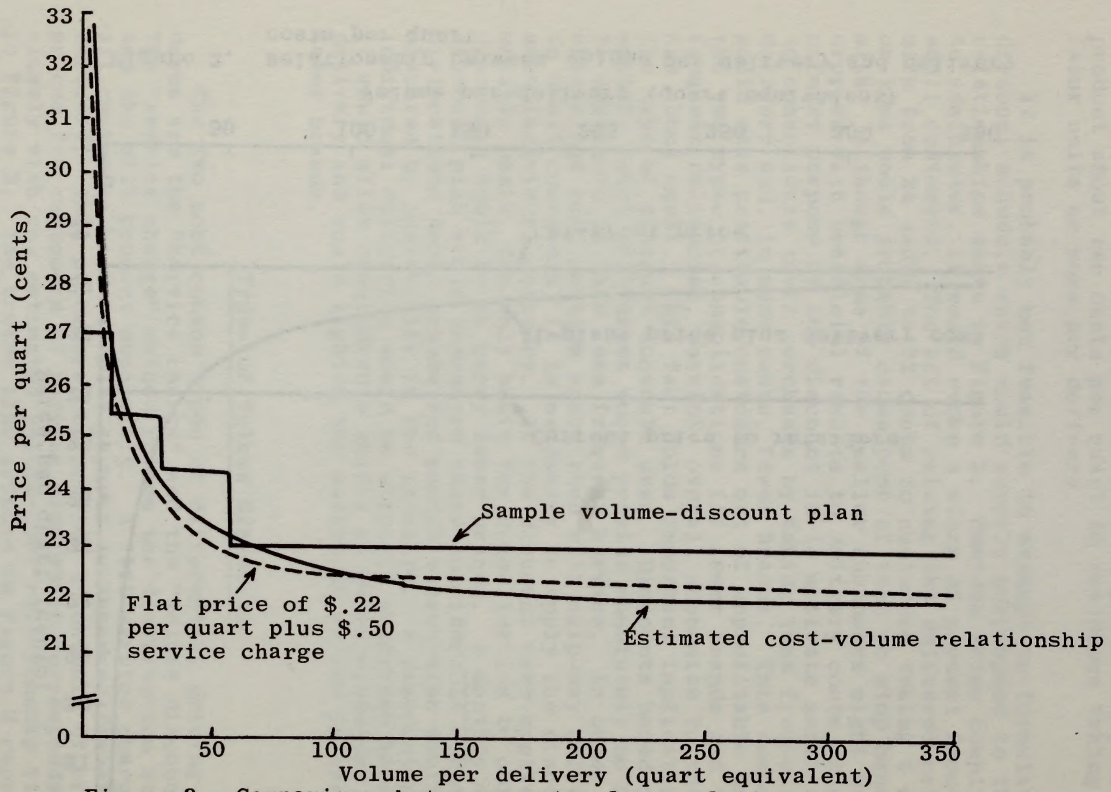

Figure 3. Comparison between cost-volume relationship and selected volume-pricing plans

per delivery. The price of 22 cents per quart of milk approximates the at-plant price of milk. The use of this procedure would require a downward adjustment of the nominal price of each item of milk from the normal "delivered price" to the price representing the at-plant price--a reduction of about 8 or 9 per cent on each item. The loss in revenue to distributors would be made up through the collection of service charges.

While the flat "service charge" method of pricing accurately reflects the cost-volume relationship as estimated in the analysis, it probably would not be practical to use. The term "service charge" has an unpleasant connotation to the customers in that it appears to be an added charge. Also, such a drastic increase in the "effective" delivered price for small customers would probably cause them to stop handling milk. Most distributors would prefer that the small customers accept less frequent delivery rather than discontinue delivery entirely.1/ Therefore, a somewhat smaller price increase with a possible price reduction through consolidation of deliveries would be preferred.

For these reasons the volume discount is widely considered the most feasible plan. The volume discount starts with a base price and allows price discounts on larger volumes. Since lower prices will be received under the larger discounts, it is necessary to increase the base price of milk if the same total revenue is to be obtained from the discount plan as was formerly attainable under the flat pricing plan. If a sufficiently complex discount schedule is used, it is possible to approximate closely the true cost-volume relationship. However, a discount schedule with three or four discounts is probably as complex as can be easily used. Here again it is probably not feasible to increase the base price enough to cover the costs of serving the small customer. Thus large customers may still be required to subsidize the delivery of milk to small customers, though not to the same extent as formerly. A proposed discount schedule which seems to approximate the estimated cost-volume relationship is shown in Figure 3. This schedule starts with a base price of 27 cents per quart and involves discounts as indicated in Table 9.

1/ Even though the particular procedure selected in this study for the allocation of total delivery costs indicates that a delivery of five quarts costs ten cents per quart, the marginal (or additional) cost of making the delivery from an existing route is much smaller. Therefore, the loss of even the smallest customers may be viewed with alarm by some distributors. However, if the loss in customer numbers is equally divided among distributors, each distributor would regain the loss by added volume in those stops in which his brand was retained.

Table 9. Arbitrary discount schedule to be applied to individual deliveries

Value of sale (dollars)	Discount (per cent)	Effective price per quart a/ (dollars)
0 - 2.49	0	.270
2.50 - 7.49	6	.254
7.50 - 14.99	10	.243
15.00 - over	15	.229

a/ With corresponding prices for other items.

This schedule is designed so that a distributor with the same size distribution of customers as was included in the sample would receive the same total revenue from wholesale sales as he did under the flat price of 24 cents per quart (with corresponding prices for other items). Distributors with a higher proportion of small customers would receive more total revenue, and those with a higher proportion of large customers would receive less total revenue.

The discount schedule is stated in terms of dollars per delivery because the salesmen normally total up the bill each time and are accustomed to working with monetary units. The discount schedule may have to be revised with each substantial change in milk prices.

The manner in which the discount is introduced is important in gaining industry acceptance. It is not feasible, for example, to initiate a volume discount in wholesale delivery with a parallel program in home delivery. The application of a volume discount would enable large customers to sell milk at lower prices than small stores and home delivery. Probably this price differential would be sufficient to cause many housewives to discontinue home delivery and purchase milk in large grocery stores. The loss of some of the smaller home delivery customers may be sustained without serious effects on the delivery routes. However, a mass change to store buying would have serious effects on distributors having a high proportion of retail sales. For this reason, a realistic volume-discount program on home delivered milk should be introduced simultaneously with the program on wholesale delivery. Many home delivery customers are large enough to deserve substantial discounts. Research shows that a realistic volume-discount program for home delivery customers would make it possible to deliver milk to many houses at prices that would compete with the

supermarkets.1/ This would prevent the loss of the larger home delivery customers to stores. Some of the small customers would change to store buying, but this would be no serious loss. One of the real advantages of such a program would be to increase the average size of delivery to homes. The practice of some housewives of taking milk on Monday, Wednesday and Friday from one distributor and Tuesday, Thursday and Saturday from another distributor will be stopped.

Expected Results from a Volume Discount

It is possible to make some predictions about the effects of a volume-discount program such as the one described. Since the largest discount of 15 per cent begins at deliveries of $15.00 per delivery, a grocery store would have no incentive to drop a brand whose daily volume was selling at a rate in excess of $15.00. A distributor whose daily volume in some stores is less than $15.00 per day might offer every-other-day delivery in order to bring the volume up to $15.00 per delivery. Thus distributors would have little fear of being dropped from large stores. There would be some reduction in the number of brands carried in the smaller stores or the frequency of delivery or both. Since the discounts could be obtained by decreasing the frequency of delivery, small stores might be expected to pursue this method rather than cutting down on the number of brands and losing the benefit of brand preference by customers. However, if refrigeration space is limited, the stores have no alternative but to reduce the number of brands. This would occur in the smaller grocery stores which normally carry two or three brands. There might be some difficulty on the part of some distributors in expanding into new sales areas where considerable time is required to build up sales volumes to a sufficient basis to offer discounts. Schools, drug counters and restaurants normally carry only one brand, so any change in their purchases would be through less frequent delivery.

Cost Savings through Less Frequent Delivery

If the sample discount schedule is applied on each individual delivery, approximately two-thirds of all wholesale customers would have some monetary incentive to accept every-other-day service. About one-fourth of the customers would

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1/ D. A. Clarke, California Agr. Exp. Sta. Bul. 757, Dec. 1956, estimated that delivery costs to homes for deliveries of 10 quarts or more per delivery were approximately two cents per quart. This price would compare favorably with supermarket prices when the delivery cost to supermarkets of 1/2 cent per quart and a store margin of two or three cents per quart are added.

have an additional monetary incentive to handle fewer brands. These conclusions are based on the size distribution of the customers included in the sample and are based on the assumption that the customers will first make the change to every-other-day service and then accept fewer brands only if there are further economies to be gained by so doing.

There is little experience or data available to predict accurately the response of stores to the monetary inducement to consolidate purchases and obtain the volume discount. Probably somewhat less than two-thirds will actually make the change to every-other-day delivery. Some may prefer delivery every day to the lower price obtainable under every-other-day delivery. Others may have limited refrigerator space and will be motivated to accept fewer brands rather than every-other-day delivery. In spite of these two factors, however, the shift to every-other-day delivery should be significant.

Cost savings obtainable by putting small stops on a skip-day delivery basis are substantial. The smaller number of stops per day reduces labor costs even though average size of stops increases. This is a reflection of reduced delivery time per quart with larger deliveries. Fewer stops per day also mean less driving time and smaller variable truck costs. Since labor time on some routes may be reduced to less than an average work day, the routes can be reorganized to include stops not previously accommodated on the route. These may be new accounts or accounts taken from other routes. A plant with a large number of routes can eliminate some routes by dividing up the accounts and adding them onto remaining routes. The consolidation of routes saves nearly $30 per day for each route eliminated.

The routes included in the sample were analyzed to estimate the magnitude of cost savings obtainable by consolidating routes. It was found that the customers in the sample could have been served by 17 per cent fewer routes if the customers having monetary incentive to accept every-other-day delivery were actually served on that basis. Smaller additional cost savings would arise because of lesser route mileages and the acceptance of fewer brands by the customers having some monetary incentive to do so.

The analysis indicates that the magnitude of cost savings obtainable by a volume-discount pricing procedure amounts to approximately 1/2 cent per quart. Gross cost savings for North Carolina distributors could then possibly total approximately two million dollars annually at 1960 sales volumes.

APPENDIX A

The analysis of the relationship between cost of delivery and volume of delivery is facilitated by the use of a volume index. Since some individual deliveries of milk may involve as many as thirty different items, the construction of a suitable volume index is difficult. Volume can be measured in terms of (1) monetary value of delivery, (2) in quart equivalents by volume, or (3) quart equivalents in terms of delivery labor requirements. Each measure has its advantages and disadvantages. The measure should be easy to apply and constant over time. None of the measures satisfy these two criteria exactly.

If volume delivered is measured in terms of value, the functional relationship between delivery costs and volume would change with each change in price. The entire analysis would then have to be repeated with each price change. If volume is measured in "quart equivalents by volume," the measure would have the advantage of never becoming obsolecent through changes in prices. However, the deviations from the mathematically fitted regression line due to different proportions of milk items delivered in each delivery would be so great as to minimize confidence in the relationship.

The measurement of volume by quart equivalence in terms of delivery labor requirements was the measure selected for the analysis. Although the measure is not commonly used in the industry vocabulary, it has special advantages. Deviations around the mathematical relationship are substantially less than would be the case with other volume measures.since the size and container variation is eliminated. The measure becomes obsolete only when technology changes the physical delivery time requirements. The measure is translated back into value terms for use in the volume-discount pricing schedule by the relationship:

$$R = a + bV$$

where R = the monetary value of the milk delivered and V = the volume measured in quart equivalents of labor requirements.

APPENDIX B

Instructions for Timers on Wholesale Delivery Routes

The following steps usually describe a typical delivery operation at such stops as restaurants, coffee shops, hotels, commissaries and small grocery stores:

The driver steps from the truck, walks into the store, walks back to the showcase or refrigerator, reaches in and counts the items, moving them or arranging them as he counts. At the same time, or immediately after counting, he writes

down on the sales slip what is needed. He computes the price and cost of the total bill. He then walks out of the store and back to the truck, opens the door to the refrigerated milk compartment and climbs in to select the required items. He places the items in a case, carries them into the store and places them by the showcase (with large orders he may use a hand truck). He places the items in the showcase and arranges them. He then walks to the proprietor of the store and hands him the sales tag. The proprietor either signs the tag or pays cash. The driver then collects empty cases and bottles and walks back to the truck, places the cases in the back of the truck, walks to the driver's seat, climbs in, and is ready to proceed to the next stop. There may be some variations to this routine, but this describes the basic tasks.

For ease in timing, the entire operation is broken into thirteen delivery elements. Each element is timed separately and recorded in the appropriate place on the timer sheet. The delivery elements, their description, their column number on the timer sheet, and their distinct beginning and ending points are as follows:

(1) Secure Order - This is the first element for which the stop watch is used. The element begins when the driver gets out of the truck cab. The driver then walks into the store, opens the display case, arranges the milk in the display case, pushing the older milk to the front. At the same time he counts the packages and estimates the daily requirements, checks the condition of the product and writes the order on the sales tag, computing the total value at the same time. He then walks back out to the truck and makes up the order. The timing of this element stops when the driver opens the back door of the truck to obtain the milk.

Exception: On some large stops the driver knows that at least two trips will be required. In this case he loads the hand truck before entering the store and takes the load with him when he goes. After he has placed the load beside the delivery case, he secures the order and returns to the truck for the second load. The timing of the elements in this case are as follows: Since the driver initiates the "put up order" first, this element must be timed first. Then the time involved in taking the product into the store would be divided fifty-fifty between "delivery" and "secure order," unless the first trip is retarded because of a heavy load. In this case more time will be allotted to delivery. Beginning of element - when driver opens door of truck to step down. End of element - when driver reaches up to open the refrigerated compartment to put up the order.

(2) Put Up Order - Includes the time elapsed between the time the driver opens the door to the truck load until the driver shuts the door and starts for the store. This

element includes selection of the milk and piling the cases on the hand truck (if this is done). In some grocery stops the driver interrupts this element to mark prices. The timing of "put up order" will then be timed in two parts and recorded in two figures. Summation can be achieved later.

(3) Deliver - Includes the time elapsed between the moment the driver starts to the store and the moment he sets the load down at the point of delivery. It does not include putting the milk into the display case.

(4) Put in Icebox - This element begins when the driver starts to place milk into the showcase. He may put milk in several different iceboxes in different rooms, involving considerable walking around. Tnis time is also included in the element. The element ends when the last item is placed in the icebox. This element does not include hand trucking the excess milk back to the cold room for later use. That time is listed under "other services."

(5) Wait - Includes the time involved when the driver is not working, but is waiting on the customer to come and check the number of packages, is walking around to locate the proprietor, or otherwise waiting on the proprietor to finish other duties before he can help the driver finish his delivery. This waiting time is usually regarded as unavoidable.

(6) Talk - Includes the time the driver is not working or waiting but is talking idly with the customer. If the driver is actively promoting sales, make such a notation beside the time entry. If the driver is working as he talks, this time is not entered under "talk." The "talk" element applies only when the driver is not working.

(7) Secure Signature - Includes the time required for the driver to extend the sales tag to the customer, the time required for the customer to count the items, sign the tag and return it to the driver. If the driver has to spend some time locating the proprietor, this time is entered as "wait."

(8) Secure Cash - Includes the time required for tne driver to extend the tag, the time required for the customer to count out the cash, the driver to make change and the driver to put the money in his pocket.

Note: In some cases both "secure signature" and "secure cash" are accomplished. In large groceries a checker in the back room checks the items and initials the sales slip. The clerk at the office or check out stand pays the money.

(9) Complete Delivery - Includes the time required for the driver to pick up empty cases and returned milk, walk back to the truck and place the cases in the truck. The element ends when the driver is seated in the cab of the truck.

(10) Arrange Load - This element consists of rearranging the empty cases and milk on the truck to expedite further unloading and will not be accomplished very often - probably only after large stops. Minor items will be arranged often, such as the moving of a single empty case, but this time can usually not be separated from "put up order," and is not counted in "arrange load."

(11) Mark Prices - This element may be accomplished while the order is being "put up" in the truck, or it may be accomplished in the store at the point of delivery. If it is accomplished in the truck while the order is being "put up," the total time is divided between "put up order" and "mark prices." In this case the entry may be placed either in "put up order" or in "mark prices" but a notation must be made as to the nature of the time. If the time is placed in "mark prices," the timer should add "(and put up order)" adjacent to the entry. "Mark prices" includes walking after the price marker, wiping the tops of the cartons dry, marking prices and replacing the price marker.

(12) Other Services - At large stops the driver frequently performs a number of complimentary services, such as putting surplus milk in the cold room in the back of the store, mopping the floor, cleaning the show case, etc. A note should accompany such an entry to explain the nature of the service. If the driver returns to the store to perform some service after the route is accomplished (at night, say), the timer should accompany him and record the tasks and times.

(13) Personal Time - Includes coffee breaks, lunch or breakfast, washing hands, going to toilet, etc.

Other Information

In addition to the thirteen actual timing elements, there are certain other types of information which must be recorded. At the top of the timer's sheet there are eight items that are recorded only once during the route.

Nonrecurring information:

A. Plant - Record the name of the plant.

B. Date - Record the date for which the time data are applicable.

C. Route Number - Each plant uses a route numbering system. The numbers may start at 60 and run in integers of 2 up to 80, for example. Each route will use a number which will apply only to that route. It will be well to record the name of the driver as well.

D. Mileage (start) - Record the mileage registered on the odometer when the route is begun. Some trucks do not have odemeters accurate to tenths of a mile. In this case, estimate fractions of miles by noting the position of the last digit on the odometer. Accuracy to 1/2 mile will thus be obtained.

E. Time In - Record the time at which the driver arrives at the plant.

F. Time Out - Record the time at which the driver leaves the plant to make his first delivery. In the cases of refrigerated trucks this time may coincide with E above since the truck will already have been loaded.

G. Time Back - Record the time at which the driver returns to the plant at the completion of the route. In a few cases the driver will return to the plant for more milk to make a second trip. In this case a second entry in "time out" and "time back" will be required.

H. Time Home - Record the time at which the driver leaves the plant at the close of the working day.

There is also some information that will be recorded at each stop but will not be a part of the stop watch timing. They are:

(1) Stop No.____ - Stops will be listed in numerical order, such as 1, 2, 3, 4, -------- etc.

(2) Mileage at Stop - Record the mileage as the truck comes to a halt in front of the stop. Read the odometer to 1/2 mile accuracy. If the odometer registers tenths of miles, record it in tenths. It will usually be necessary to write down only the last 3 digits.

(3) Time at Stop - Record the time that the truck comes to a halt in front of the stop. A wrist watch will be adequate for this purpose. Accuracy to the nearest minute is sufficient.

(4) Ticket No.____ - The sales tags from the drivers' sales books are consecutively numbered, usually with red numbers at the top of the ticket, for example, 039191. The ticket number will have to be recorded at each stop. The recorder cannot assume that the ticket numbers will be given out in numerical order since the driver often makes out the heading of the ticket in advance but does not complete the route in the same order.

(5) Type Stop - Record the type of establishment, whether it is a restaurant, hotel, grocery store, etc. The following code will be adopted to facilitate the recording:

G = grocery store
H = hotel
R = restaurant, coffee shop
C = commissary, drug counter, dairy bar, etc.

(6) Number of Steps - Count and record the number of steps from the truck to the point of delivery. It will probably be wise for the timer to accomplish the measurement of this element as the driver is on his way into the stop to to secure the order. However, if the stop is one for which the order is not secured (known in advance), it may be easier to count the steps as the delivery is completed. The counting of steps should be accomplished whenever the timer finds it most convenient.

(7) Number of Distributors - List the number of distributors who service this stop with milk. Include in the recorded number the distributor under observation.

(8) Time from Stop - Record the wrist watch time as the driver is reseated in the driver's seat and is ready to proceed to the next stop.

G = grocery store
H = hotel
R = restaurant, coffee shop
C = cleaners, drug counter, candy bar, etc.

(5) Number of Steps - Count and record the number of steps from the truck to the point of delivery. It may probably be wise for the driver to accomplish the accomplishment of this element as the driver is on his way into the store to secure the order. However, if the stop is one for which the order is not secured (route in nature), it may be wise to count the steps as the delivery is completed. The number of steps should be accomplished whenever the driver finds it most convenient.

(6) Number of Distributors - Count the number of distributors who service this step with milk. Include in the record under the distributor under observation.

(7) Time from Step - Record the exact point time as the driver is received in the driver's seat and is ready to proceed to the next stop.

Agricultural Experiment Station

North Carolina State College

Raleigh, N. C.

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Bulletins of this station will be sent free to all citizens who request them.